D-A143 403 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS WILLIMANTIC RESERVOIR..(U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV JUN 79 1/1

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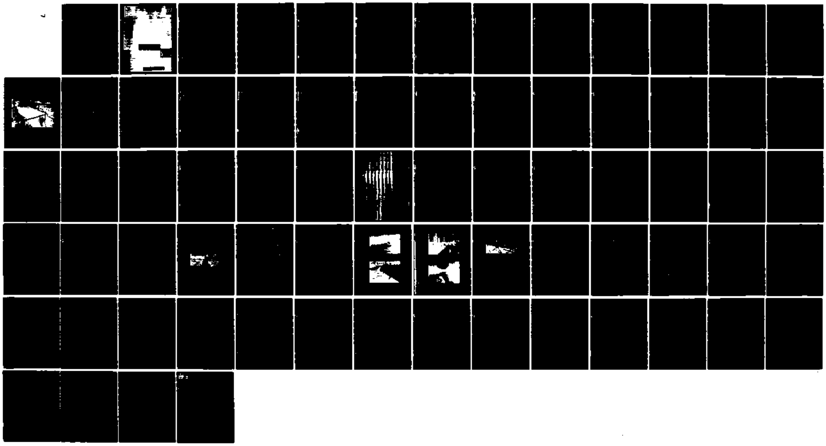

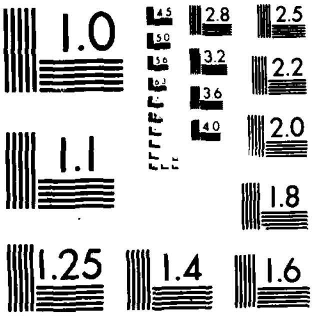

MICROCOPY RESOLUTION TEST CHART
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AD-A143 403

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[illegible] WINDHAM, CONNECTICUT

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DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF
NEDED

AUG 24 1979

Honorable Ella T. Grasso
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

Dear Governor Grasso:

I am forwarding to you a copy of the Willimantic Reservoir Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, City of Willimantic, Willimantic, Connecticut.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely yours,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

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DAMS, INSPECTION, DAM SAFETY,

Thames River Basin
Mansfield-Windham, Conn.
Willimantic Reservoir Dam

20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

Willimantic Reservoir Dam is a stone masonry and concrete gravity dam with a full crest spillway constructed about 1885. The dam has a maximum height of 29 ft. and is approx. 491 ft. in length.The dam is considered to be in GOOD condition. This dam is classified as INTERMEDIATE in size and a HIGH hazard structure in accordance with the recommended guidelines established by the Corps of Engineers.

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THAMES RIVER BASIN

MANSFIELD - WINDHAM, CONNECTICUT

WILLIMANTIC RESERVOIR DAM

CT 00198

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I - INSPECTION REPORT

Identification No.: CT 00198

Name of Dam: Willimantic Reservoir Dam

City: Willimantic

County and State: Tolland and Windham County,
Connecticut

Stream: Natchaug River

Date of Inspection: 17 April, 1979

BRIEF ASSESSMENT

Willimantic Reservoir Dam is a stone masonry and concrete gravity dam with a full crest spillway constructed about 1885. The dam has *a maximum height of 29 feet and is approximately* 491 feet in length. The stone masonry and concrete spillway has a total crest length of about 491.0 feet and is divided into two distinct sections that have a difference in elevation of 1.2 feet. A water pumping station is located at the right abutment and contains low-head raw water pumps and a high-head vertical turbine pump for pumping treated water to the Willimantic water distribution system.

Due to its age, Willimantic Reservoir Dam was neither designed nor constructed by present state-of-the-art procedures. Based upon the visual inspection at the site and the lack of engineering, operational and maintenance data, there are areas of concern which must be corrected to assure the long-term performance of this dam. The dam is considered to be in GOOD condition. Deficiencies include indication of overtopping potential, limited discharge capacity of the spillway and outlet works, inoperable low level outlet through the spillway, and spalling of the downstream face of the left section of the spillway.

This dam is classified as INTERMEDIATE in size and a HIGH hazard structure in accordance with the recommended guidelines established by the Corps of Engineers.

The test flood outflow for Willmantic Reservoir Dam is equal to 106,000 CFS (635 CSM) when Mansfield Hollow Reservoir upstream is full and 89,000 CFS (533 CSM) when it is empty. With Mansfield Hollow Reservoir full, the PMF will produce overtopping at Willimantic by 8.6 feet and empty by 6.7 feet. For the purposes of this study, Mansfield Hollow Reservoir was considered empty for the one-half PMF event and no overtopping would result at Willimantic. The maximum spillway discharge at Willimantic Reservoir Dam is equal to 38,125 CFS.

It is recommended that the Owner engage the services of an engineer experienced in the design of dams to accomplish the following: evaluate and develop a plan of restoration and rehabilitation of the low-level outlet through the spillway, evaluate the impact of the test flood on the existing facilities and conduct further hydrological studies for spillway adequacy and for repairing the concrete facing of the spillway.

Recommendations and remedial measures listed above and detailed in Section 7 should be implemented by the Owner within two years after receipt of this Phase I Inspection Report.

CE MAGUIRE, INC.

BY: Richard W Long
Richard W. Long, P.E.
Vice President

STATE OF CONNECTICUT
RICHARD W. LONG
NO. 9568
REGISTERED
PROFESSIONAL ENGINEER

This Phase I Inspection Report on Willimantic Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Joseph W. Finegan

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

Joseph A. Mc Elroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, CHAIRMAN
Chief, Structural Section
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, DC 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or to property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any opportunity to detect unsafe conditions.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonable possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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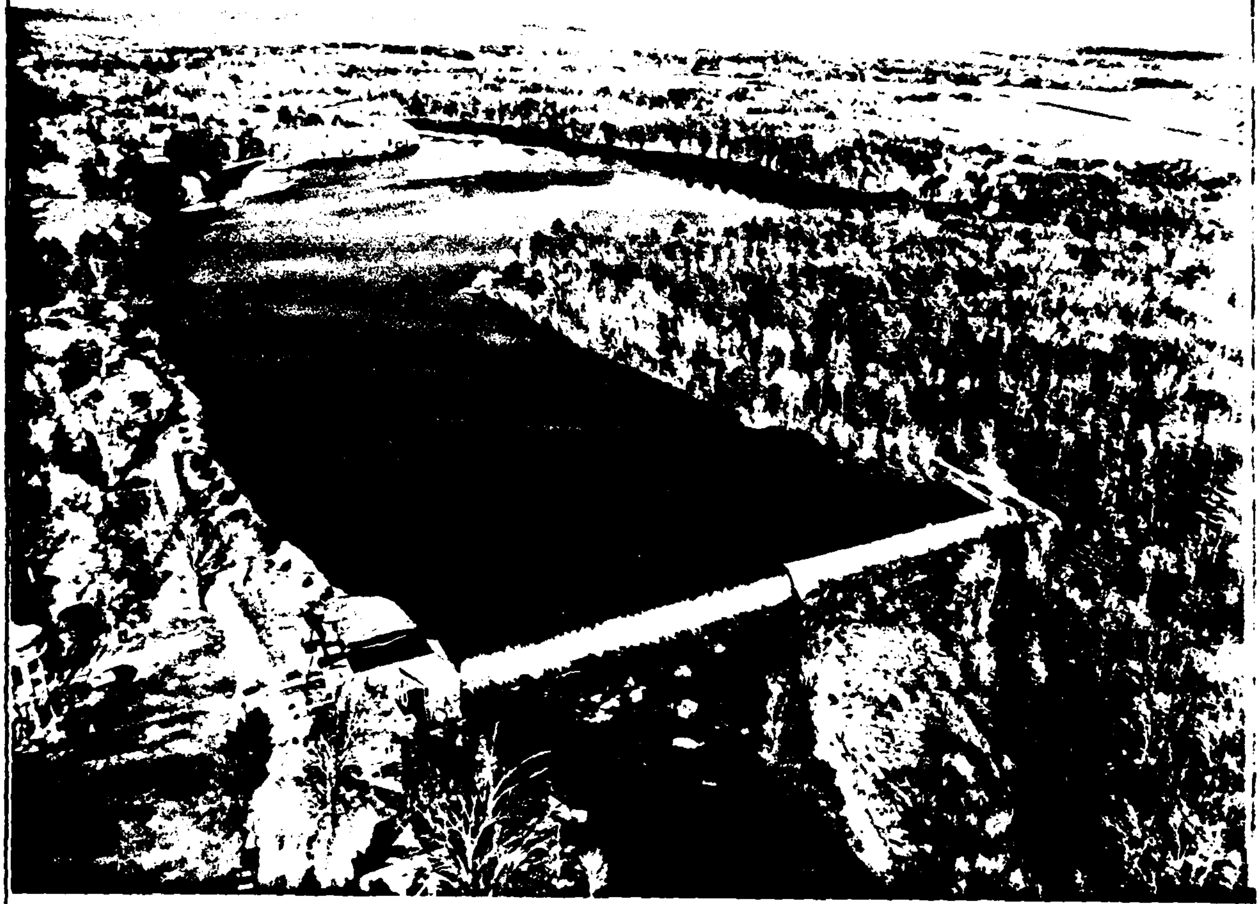
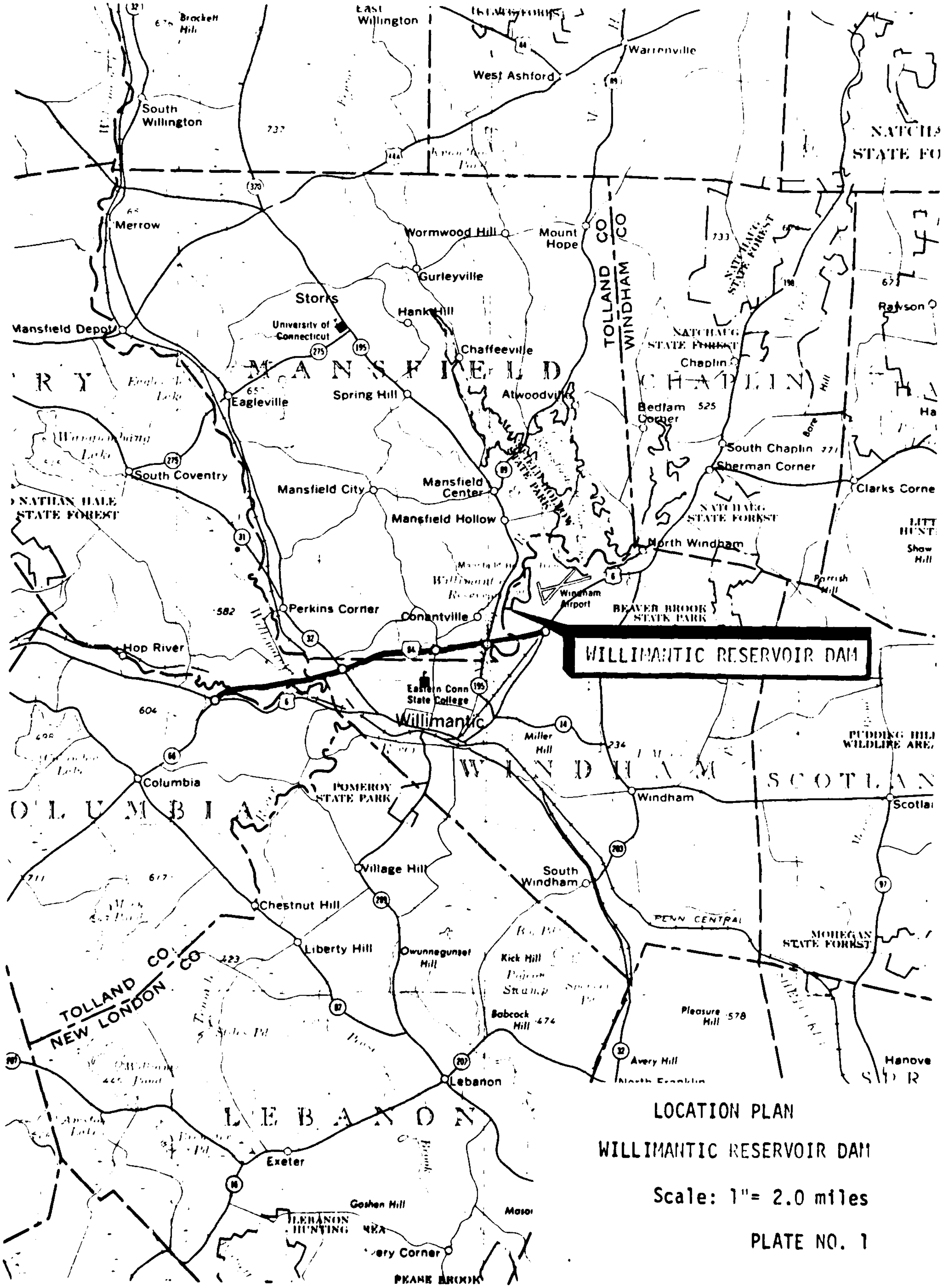
APPENDICES



Willimantic Reservoir Dam - Overview Photo



LOCATION PLAN

WILLIMANTIC RESERVOIR DAM

Scale: 1"= 2.0 miles

PLATE NO. 1

NATIONAL DAM INSPECTION PROGRAM

PHASE I - INSPECTION REPORT

NAME OF DAM: WILLIMANTIC RESERVOIR DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army through the Corps of Engineers to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. C-E Maguire, Inc., has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed was issued to C-E Maguire, Inc., under a letter from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0015 has been assigned by the Corps of Engineers for this work.

b. Purpose.

1. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

2. Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

3. To update, verify and complete the National Inventory of Dams.

1.2 Description of the Project

a. Location. Willimantic Reservoir Dam is located in the Town of Mansfield, Tolland County, and the Town of Windham, Windham County, Connecticut. Coordinates of the dam are about 41° 44.4'N Latitude and 72° 11.7'W Longitude. (See Plate No. 1). The dam impounds water from the Natchaug River which drains a 167 square mile watershed of rolling terrain. The reservoir has a total surface area of 11[illegible] acres. The impoundment is aligned in a generally north-south axis, with the dam located at the southern extremity.

b. Description of Dam and Appurtenances. The Willimantic Reservoir Dam is approximately 490 feet in length and is a concrete and stone masonry gravity structure. The dam spillway has two distinct crest elevations and is constructed of stone masonry with a concrete facing. There is a low-level outlet structure through the spillway which is inoperable at this time.

A water pumping station and headrace is located at the right abutment. The headrace directs water to two intake structures: a raw water intake for the Willimantic Water Treatment Plant and an intake for a high-head vertical turbine pump which pumps treated water to the City's water supply system.

c. Size Classification. Impoundment capacity calculated for the dam is 1670 Ac.-Ft. with a height of 29.0 feet. This impoundment capacity warrants classification as INTERMEDIATE.

d. Hazard Classification. The dam is classified as a HIGH hazard structure because failure could cause the loss of lives and extreme property damage. Estimated damages include homes (5), commercial properties (3) U.S. Route 6, Conrail RR, Willimantic water supply system, utilities (telephone and power adjacent to the damaged roads) and wide spread flooding. The estimated water depth due to the possible dam failure discharge of 50311 CFS may be in the range of 19.0 feet ±. See Appendix D for calculations.

e. Ownership. The Willimantic Reservoir Dam is owned by the City of Willimantic, Connecticut.

f. Operator. Operating personnel are under the direction of:

Mr. Homer B. Roy
Superintendent of Water
Willimantic Water Department
Box 257
Willimantic, CT 06226
203/456-2217

g. Purpose of Dam. The Willimantic Reservoir Dam impounds water from the Natchaug River for the water supply system for the City of Willimantic. The average demand for water from the reservoir is 2.5 MGD.

h. Design and Construction History. The dam was reportedly constructed in 1885 and was subsequently renovated in 1918, 1936, 1938 and 1955. A photograph taken during the original construction is included in Appendix B. The renovations completed in 1918 apparently consisted of repairs to the crest and the placing of a concrete facing on the crest and downstream face of the spillway. The concrete facing on the spillway was renovated in 1933. The dam was also repaired in 1938 and again in 1955 after hurricane floods caused partial failures of the dam. Plans for the renovations of 1918 and 1933 are included in Appendix B. No construction records or plans are available for the repairs carried out in 1938 and 1955.

i. Normal Operating Procedures. Willimantic Reservoir is operated as part of the water supply system for the City of Willimantic, Connecticut. In addition to supplying potable water to the City, water is drawn from the reservoir to power the vertical turbine pump which serves as the high-head water supply pump for Willimantic. Water for both purposes is drawn on demand.

1.3 Pertinent Data

a. Drainage Area. Willimantic Reservoir is located in Windham County in northeastern Connecticut. The basin is generally rectangular in shape with a length of approximately 9 miles, a width of 12 miles, and a total drainage area of 167.0 square miles (See Drainage Basin Map in Appendix D). The topography is generally hilly with elevations ranging from a high of 1200 feet to 182 feet at the spillway crest. Basin slopes are flat to moderate having slopes of 0.01 feet/foot to 0.02 feet/foot. The average time of concentration for the entire drainage basin is estimated to be 15 to 20 hours.

Due to the relatively large size of the watershed and the concentration time, it is improbable that all surface runoff will peak at the reservoir simultaneously during a high intensity rainfall event. In addition, the large upstream storage areas in the watershed tend to dampen and delay the peak of the surface runoff. Mansfield Hollow Dam, a flood control structure operated by Corps of Engineers is located just upstream of this dam and has a significant impact on the flows over this facility.

b. Discharge at Dam Site. There are no discharge records available for this dam, however, discharge records are available from the U.S. Geological Survey Gaging Station located 1.9 miles downstream which are applicable to the dam site because of its close proximity. Listed below are calculated discharge data for the spillway and outlet works:

1. Outlet Works:
   To Natchaug River - One 4-ft. wide by 4-ft. high rectangular gate.

2. Maximum Known Flood at Dam Site -
   14,200 CFS-March 24, 1936
   32,000 CFS-September 21, 1938
   (May have been affected somewhat by upstream dam failure)

3. Overflow spillway capacity @ top of Dam - 38125 CFS at Elevation 187.29.

4. Overflow spillway capacity at "Test Flood Level" - 105,500 CFS at Elevation 197.9.

5. Gated outlet capacity at normal pool level - 360 CFS at Elevation 181.27 (spillway crest).

6. Gated outlet capacity at maximum pool level - 425 CFS at Elevation 189.27.

7. Total project capacity at "Top of Dam" - 38550 CFS @ Elevation 189.27.

8. Gated outlet capacity at test flood level - 500 CFS at Elevation 197.9.

9. Total project discharge at "Test Flood Level - 106,000 CFS @ Elevation 197.9.

c. <u>Elevations (Feet above National Geodetic Vertical Datum, NGVD)</u>

1.	Streambed at centerline of dam -	Upstream - not observable Downstream - 159.0
2.	Maximum Tailwater	Upstream and downstream elevations in 1938 were 191.9 and 180.7 respectively.
3.	Upstream Inlet Invert	159.5
4.	Recreation Pool	N/A

5.	Full Flood Control Pool	N/A
6.	Spillway Crest	181.27 for 269.9 feet length 182.47 for 221.4 feet length
7.	Top of Dam	189.27
8.	Test Flood	197.9

d. Reservoir Length (in Feet)

1.	Maximum Pool	5,000
2.	Recreation Pool	N/A
3.	Flood Control Pool	N/A

e. Storage (Ac-Ft.)

1.	Recreation Pool	N/A
2.	Flood Control Pool	N/A
3.	Test Flood Pool	2,659
4.	Spillway Crest Pool	750
5.	Top of Dam (El. 158.0)	1,670

6. Net storage between top of dam (EL. 189.27) and spillway crest is 920 Ac.-Ft. and represents 0.10 inches of runoff from the drainage area of 167.0 square miles.

7. Each foot of surcharge storage above spillway crest to top of dam equals 0.012 inches of runoff from the drainage area of 167.0 square miles.

f. Reservoir Surface (Acres)

1.	Top of Dam	115
2.	Test Flood Pool	115
3.	Flood Control Pool	N/A

	4.	Recreation Pool	N/A
	5.	Spillway Crest	115
g.	<u>Dam</u>		
	1.	Type	Stone masonry and Concrete gravity dam
	2.	Length	491.3 feet
	3.	Height (main embankment)	29 feet maximum
	4.	Top Width (main embankment)	10 feet
	5.	Side Slopes	N/A
	6.	Zoning	N/A
	7.	Impervious Core	N/A
	8.	Cutoff	N/A
	9.	Grout Curtain	N/A
	10.	Other	--
h.	<u>Diversion and Regulating Tunnel</u>		N/A
i.	<u>Spillway</u>		
	1.	Type	Overflow, broad crest, ogee type.
	2.	Length of Weir	491.3 feet
	3.	Crest Elevation	181.27 for 269.9 ft. 182.47 for 221.4 ft.
	4.	Gates	None
	5.	U/S Channel	Natural bed
	6.	D/S Channel	Natural bed
j.	<u>Regulating Outlet</u>		

Refer to paragraph 1.2b

"Description of Dam and Appurtenances" for description of outlet works.

1.	Downstream invert	159.0
2.	Size	One-4 ft. wide by 4 ft. high rectangular stone masonry opening.
3.	Control mechanism	Manually operated vertical lift gear mechanism, under water
4.	Other	Outlet from High-head vertical turbine pump - Outlet is separated from the main channel by stone masonry dividing wall.

SECTION 2

ENGINEERING DATA

2.1 Design. The following documents which contain the principal information available for this dam and its appurtenances were reviewed in the preparation of this report.

Drawings

1. Sketch of Proposed Repairs to Natchaug Dam (Willimantic Reservoir Dam), Willimantic, Connecticut, September 10, 1918, by Aberthaw Construction Company.

2. Natchaug River Dam (Willimantic Reservoir Dam), Willimantic, Connecticut, June, 1936 (3 sheets), Chandler and Palmer, Consulting Engineers.

3. Natchaug Dam (Willimantic Reservoir Dam) Willimantic Water Works, J.T. Fanning, C.E.

2.2 Construction. No record of construction or subsequent repairs is available for this dam. It is assumed that the above referenced drawings illustrate the "as built" condition. A photograph taken during the original construction of the dam is included in Appendix B.

2.3 Operation. No operation records of this facility are maintained.

2.4 Evaluation

a. Availability. The information noted above for this facility is available from the files of the office of the City Engineer, Willimantic, Connecticut.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspections, past performance and sound engineering judgment.

c. Validity. The validity of the limited data must be verified.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. Based on visual inspection, history and general appearance, the Willimantic Reservoir Dam and appurtenances are judged to be in GOOD condition.

There are large amounts of brush and small trees piled in the downstream channel which would restrict flow.

The downstream face of the left section of the spillway is badly spalled.

Reference stationing is indicated on the photo index sheet in Appendix C.

b. Dam. The dam is a stone masonry and concrete gravity structure. The spillway constitutes the entire length of the dam. No construction drawings are available, nor are the details of design and subsequent repair known.

c. Spillway

The full crest spillway is divided into two sections with the right section having a lower elevation than the left section, as shown in Photos C-1 and C-2. The right section of the spillway was overflowing at the time of inspection.

A small pool of water was observed at the downstream toe of the left spillway section. It is unclear whether this water is from seepage below the dam or run-off from the left abutment area. An area of spalled concrete was noted on the downstream face of the left spillway section, as noted in Photo C-5. Slope erosion has occurred adjacent to the left spillway training wall.

The right training wall is stone masonry with mortared joints and in good condition. The left training wall appears to be concrete and is also in good condition.

The downstream channel, shown in Photo C-2, appears to be in generally good condition. The left side of the downstream channel appears to have been recently cleared of vegetation as shown in Photo C-2. A pile of cut stone blocks was noted at the downstream toe of the left spillway section.

d. Appurtenant Structures. The appurtenant structures for this dam are the low-level spillway outlet works and the water pumping station located at the right abutment.

1. Outlet Works. The outlet works is located at the spillway, and is reported to be a 4 foot by 4 foot rectangular opening with a vertical lift gate mechanism. The lift mechanism is under water at the upstream side of the spillway and reportedly has not been operated in over ten years. The outlet and gate mechanisms were not visible at the time of inspection.

2. Water Pumping Station. The water pumping station is located at the right abutment of the dam and has a headrace structure which directs water to two intakes: A raw water intake to supply water to the water treatment plant, and an intake to a high-head vertical turbine pump which pumps treated water to the Willimantic water distribution system. A tailrace from the turbine pump is located on the downstream side of the pumping station and is separated from the main channel by a stone masonry dividing wall as shown in Photos C-3 and C-4. Both the headrace and tailrace training walls appear to be in good condition. There is some spalling of the gunite facing of the headrace training wall.

d. Reservoir Area. No specific detrimental features in the reservoir area were observed during the visual inspection. The slopes of the watershed are well-covered with growth to preclude sloughing of shoreline material.

e. Downstream Channel. The downstream channel for the Willimantic Reservoir Dam is the Natchaug River. Directly below the spillway, the channel is a natural channel as shown in photo C-4. There is brush piled in the left side of the channel immediately downstream of the spillway as shown in photos C-1 and C-2.

3.2 Evaluation. Based on the visual inspection, the dam appears to be in good condition, with several areas that require attention.

The downstream face of the left spillway section is badly spalled and should be rehabilitated.

The source of the pool of water noted downstream of the left spillway section should be investigated and monitored for changes in quantity.

The brush in the left section downstream channel should be removed to improve the flow characteristics of the channel.

The low-level outlet through the spillway should be rehabilited to provide a means for lowering the level of the reservoir more rapidly in the event of an emergency. The gate lift mechanism for the outlet should be made easily accessible by maintenance personnel.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedures. The Willimantic Reservoir is a surface water storage facility for the Willimantic Water Department. The reservoir is operated as the main source of water for the City of Willimantic, Connecticut and water is withdrawn on demand at an average rate of 2.5 MGD. No other regulation of the pool level occurs.

4.2 Maintenance of Dam. No program of regularly scheduled maintenance exists for this dam.

4.3 Maintenance of Operating Facilities. Maintenance of the pumping station and equipment is performed as required.

4.4 Description of Any Warning System in Effect. Emergency action and/or warning would be coordinated through Mr. Homer B. Roy, the Superintendent of the Willimantic Water Department.

There are no formal emergency operation plans in effect for lowering the pond level in anticipation of severe storms. Monitoring of the approach of intense storm activity is normally through the U. S. Weather Service, or local weather forecasts.

4.5 Evaluation. Regular operational or maintenance procedures for this dam and its appurtenances have not been developed or implemented. The gate mechanism has not received any maintenance and should be rehabilitated and maintained.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General. Willimantic Reservoir Dam is located on the Natchaug River 1.25 miles downstream of the federally owned (Corps of Engineers) Mansfield Hollow Flood Control Dam. There is a U.S.G.S. stream gaging station on the Natchaug River located 1.9 miles downstream from the Willimantic Reservoir Dam. The Willimantic Reservoir dam has a spillway length of 491 feet and a surcharge height of 8.0 feet between the top of the dam and the spillway crest. The total length of the dam is about 491 feet. The reservoir has a total storage capacity of 750 Ac-ft. at spillway crest elevation 181.27 and can accommodate 0.085 inches of runoff from a drainage area of 167 square miles. Every foot of depth in the reservoir above spillway crest to top of dam can accommodate 115 Ac-Ft. of volume equivalent to 0.012 inches of runoff.

The spillway length of 490 feet comprises 100 percent of the total length of the dam which makes it a run of river type of facility.

Since the total available surcharge storage is 920 Ac-Ft. which is equivalent to 0.10 inches of runoff, this dam is considered a small storage facility. The maximum spillway capacity of 38,125 CFS, is equivalent to 36 percent of the "test flood", outflow of full PMF with Mansfield Hollow Dam full.

The dam is not overtopped until the outflow of 38,550 CFS (230 CSM) is exceeded. When this occurs, approximately 99 percent of the additional inflow to the reservoir becomes outflow, due to the extremely small available surcharge storage.

b. Design Data. Specific design data which is available for the Mansfield Hollow Dam is applicable to Willimantic Reservoir dam because of its close proximity. The design data for Mansfield Hollow Dam is included in Appendix D. Existing design information and information from U.S.G.S Topographic Maps (Scale 1" = 2000') were utilized to develop hydrologic parameters such as drainage area, reservoir surface area, basin slopes, time of concentration and other runoff characteristics. Elevation - storage relationships for the reservoir were approximated. Surcharge storage was computed assuming that the surface area remained constant above the spillway crest. Some of the pertinent hydraulic design data was obtained and/or confirmed by actual field measurements at the time of the field inspection.

c. Experience Data. Flooding caused by hurricanes reportedly caused partial failures of the dam in 1938 and again in 1955. The dam was rebuilt after both floods, however, no record of discharges has been kept at the dam site. Discharges have been recorded at the U.S. Geological Survey Gaging Station, Number 01122000, 1.9 miles downstream at Willimantic, since October 1930. The two highest recorded discharges at the gage are listed in Section 1.3, Pertinent Data, of this report. Since March 1952, the flow at the dam site has been regulated by releases from Mansfield Hollow Dam. Records of stages and discharges at Mansfield Hollow Dam are available from the U.S. Army Corps of Engineers in Waltham, Massachusetts. Because of their close proximity, discharge data from the U.S. Geologic Survey Gaging Station and Mansfield Hollow Dam are applicable to the dam site.

Willimantic Reservoir Dam was classified as INTERMEDIATE in size, having a storage capacity of 1670 Ac-ft. at the top of the dam. The height of the dam is 29 feet. To determine the hazard classification for this dam, the impact of its failure at maximum pool (top of dam) was assessed. As a result of this analysis, Willimantic Reservoir Dam is classified as a HIGH hazard structure as detailed in Appendix D.

The "Test Flood" and other floods of lesser magnitude, were developed for comparison purposes only. These were developed based on the "Analysis of Design - Thames River Flood Control Project -Mansfield Hollow Dam, Natchaug River, Connecticut", November, 1944, prepared by the U.S. Army Corps of Engineers. The hydrologic data contained in that report is applicable because of the close proximity of Mansfield Hollow Dam to the Willimantic Reservoir Dam. Mansfield Hollow Dam has a drainage area of 159 square miles as compared to 167 sq. mi. for the Willimantic Reservoir Dam.

For outflow values, routing procedures and dam failure profiles were computed in accordance with the guidelines developed by the Corps of Engineers. Professional judgment was used in arriving at final values as detailed in this report, which are approximate only, and are not a substitute for actual detailed analysis.

d. Visual Observations.

1. The concrete on the downstream face of the left section of the spillway is badly spalled.

2. There are large amounts of brush and small trees piled downstream of the left section of the spillway which could create debris blockage problems downstream.

3. Some spalling of the gunite facing of the walls of the headrace to the vertical lift turbine has occurred.

e. Test Flood Analysis. Recommended guidelines for the Safety Inspection of Dams by the Corps of Engineers were used for the selection of the "Test Flood". This dam is classified as a HIGH hazard structure and INTERMEDIATE in size. Guidelines indicate the full P.M.F. should be used as the test flood for this classification. The Willimantic Reservoir Dam watershed has a total drainage area of 167 square miles, 16.7 square miles, or 10 percent, is swampy or covered by storage ponds. The average basin slope is moderate and equal to 0.015, and for this analysis the watershed was considered to be flat to rolling. A "test flood" equal to the full PMF was adopted as 635 CSM, or 106,000 CFS for a drainage area of 167 square miles. A computed outflow value of 106,000 CFS from Mansfield Hollow Dam was adopted as outflow for the Willimantic Reservoir Dam because of the close proximity and the insignificant storage available at Willimantic Reservoir. Additional design data is as follows:

Mansfield Hollow Reservoir Dam located upstream is a Corps flood control reservoir and for the purpose of this study this reservoir will be empty when a flood of full PMF or 1/2 PMF magnitude hits this site. Therefore, though the Willimantic Reservoir Dam spillway capacity would be exceeded by PMF but 1/2 PMF of 14,000 CFS can be passed without overtopping with empty Mansfield Hollow in place. It is highly impractical to lengthen the existing spillway as it spans the entire river width now. The maximum outflow capacity of the spillway in a stillwater condition without overtopping of the dam is 38,125 CFS which although represents 36 percent of the test flood overflow discharge but yet is more than sufficient to pass 1/2 PMF of 14,000 CFS. The discharges of various magnitudes and frequencies (approximate only) are listed in the preceding Table. The spillway, tailwater and outlet rating curves are illustrated in Appendix D.

At the spillway crest elevation of 181.27, the capacity of the outlet structure is 360 CFS. It will require 17 hours to lower the reservoir level the first foot assuming the pond surface area is 115 acres.

Overtopping of the dam by inflow from the "test flood" cannot be prevented even if the water elevation in the reservoir is lowered several feet below the spillway crest elevation prior to a storm of full PMF magnitude. Therefore, lowering of the pond water elevation to counteract overtopping is not considered a viable solution due to insignificant storage in the Pond.

f. Dam Failure Analysis. Assuming the reservoir is full to the top of dam, the calculated dam failure discharge of 50,300 CFS will produce an approximate water surface elevation of 179.0 immediately downstream from the dam. This flow will raise the water surface over the estimated depth just prior to failure of the dam when the discharge is 38,125 CFS by 2.5 ft. Normal uniform flow, using Manning's formula, will occur approximately 17,000 feet downstream from the dam with a depth of flow equal to 18.8 feet. For this distance of 17,000 feet, the depth of flow will decrease from 20.0 feet to 18.8 feet. This failure discharge will damage approximately five homes, three commercial properties, U.S. Route 6, Conrail R.R., the Willimantic water system, utilities (those adjacent to the roadways) and considerable downstream flooding. Water surface elevations due to failure of the dam are computed and are in Appendix D.

WILLIMANTIC RESERVOIR DAM

Discharge and Surcharge Data

FREQUENCY IN YEARS	ESTIMATED DISCHARGE IN CFS	SURCHARGE HEIGHT IN FEET	SURCHARGE STORAGE ELEVATION	MANSFIELD HOLLOW DAM STORAGE CONDITION AT START OF EVENT	REMARKS
10	2900 *	1.80	183.07	-	
50	3000 *	1.90	183.17	-	
100	4000 *	2.20	183.47	-	
1/2 PMF = Standard Project Flood	14000	4.40	185.67	Empty*	
	53000	10.30	191.57	Full to Spillway Crest	
PMF = TEST FLOOD	89000	14.70	195.97	Empty*	
	10600	16.60	197.87	Full to Spillway Crest	

*These values are obtained from an attached letter in Appendix D dated 9/15/77 from COE to USGS

NOTES:

1. S.P.F. and P.M.F. discharge data obtained from Thames River Basin Regulation Manual.

2. Spillway crest elevation of Willimantic Reservoir Dam = 181.27
   Top of dam elevation of Willimantic Reservoir Dam = 189.27
   Drainage area of Willimantic Reservoir Dam = 167.0 sq. m.

3. Maximum capacity of spillway without overtopping the top of the dam elevation (189.27) is equal to 38125 CFS.

4. All discharges indicated are dependent upon the continued integrity of upstream storage reservoirs.

5. Surcharge storage is allowed to overtop the dam when exceeding the spillway capacity.

6. Test flood = one PMF = 635 CSM = 106000 CFS
   (D.A. = 167.0 square miles.)

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. The visual inspection did not disclose any immediate stability problems.

b. Design and Construction Data. There is no design and construction data for evaluation of structural stability for this dam.

c. Operating Records. There are no operating records available that could be used in a stability analysis of this structure.

d. Post-construction Changes. There is no recorded information on post-construction changes that adversely affect the stability of the dam.

e. Seismic Stability. The Willimantic Reservoir Dam is in Seismic Zone 1 and hence need not be evaluated for seismic stability according to the USCE Recommended Guidelines.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

Condition. The visual inspection indicated that the Willimantic Reservoir Dam is in Good condition. The major concerns regarding the long-term performance of this dam include:

1. Spalling of the concrete on the downstream face of the spillway.

2. Inoperability of the low level outlet in the spillway.

In addition, a minor concern was the [illegible] of trees and brush in the downstream channel.

Adequacy of Information. The lack of in-depth engineering data does not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data but is based primarily on the visual inspection, past performance history and sound engineering judgment.

Urgency. The recommendations and remedial measures described below should be implemented by the Owner within two years after receipt of this Phase I Inspection Report.

Need For Additional Investigation. No data was recovered for this inspection that indicates that formal engineering analyses were ever performed for this dam. The visual inspection and operational history indicate that attention should be given to the collection of engineering data in order that the recommendations listed below may be implemented.

7.2 Recommendations.

The Owner should engage the services of an engineer experienced in the design of dams to accomplish the following:

1. The spillway discharge capacity is considered adequate for passing 1/2 PMF with empty Mansfield Hollow Dam Reservoir in position. As spillway spans the entire river, further extension of spillway is considered impractical. However, additional steps need to be investigated to pass full PMF.

2. Evaluate the condition of the spillway surfaces and develop a program for their rehabilitation.

3. Develop a program for determining the source of and monitoring the seepage observed along the downstream toe of the spillway. Monitoring should provide a method to determine whether substantial changes in the volume or size of suspect areas occurs. Substantial changes in flow not related to changes in reservoir level should be considered as indications of a critical condition.

4. Develop a program to rehabilitate the low level outlets on the spillway to provide a means to draw down the reservoir level for maintenance or emergencies. Rehabilitation should include installing a lift mechanism which is easily accessible to maintenance personnel.

5. A topographic survey of the dam and its appurtenances should be made that will result in accurate drawings of the existing conditions to be used in a program of rehabilitation of the dam.

7.3 Remedial Measures.

a. Operating and Maintenance Procedure.

1. Develop a system for the recording of data with regard to items such as water levels, discharges, to assist those responsible for the monitoring and operation of the structure.

2. Implement a program to clear the discharge channel of vegetation in order to increase the efficiency of the outlet and removal of brush and trees piled downstream of the left section of spillway.

3. Continue the technical inspections of this facility on bi-annual basis.

4. Develop and post an emergency action plan including a warning system in order to prevent or minimize the impact of dam failure. It should include the expedient action to be taken, authorities to be contacted, and locations of emergency equipment and materials.

5. Repair all spalled concrete.

7.4 Alternatives. (Not applicable)

APPENDIX A

INSPECTION CHECK LIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Willimantic Reservoir Dam

DATE April 17, 1979

TIME 1:15 P.M.

WEATHER Overcast, 50^0

W.S.ELEV. ________ U.S. ________ D.S.

PARTY:

1. A. Reed CEM
2. R. Brown CEM
3. S. Khanna CEM
4. R. Murdock GEI
5. D. Shields GEI
6. ________
7. ________
8. ________
9. ________
10. ________

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT WILLIMANTIC RESERVOIR DAM DATE April 17, 1979

INSPECTOR ____________ DISCIPLINE ____________

INSPECTOR ____________ DISCIPLINE ____________

AREA EVALUATED	CONDITION
DAM EMBANKMENT	Note: Dam is concrete or concrete masonry gravity structure with full crest spillway
Crest Elevation	189.27
Current Pool Elevation	181.27
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	N/A
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	N/A
Sloughing or Erosion of Slopes or Abutments	Minor erosion at left abutment.
Rock Slope Protection - Riprap Failures	N/A
Unusual Movement or Cracking at or Near Toe	None observed
Unusual Embankment or Downstream Seepage	Pool of water at DS toe of left spillway section (possible seepage)
Piping or Boils	None observed
Foundation Drainage Features	Not known
Toe Drains	Not known
Instrumentation System	Not known
Vegetation	N/A

PERIODIC INSPECTION CHECK LIST

PROJECT Willimantic Reservoir DATE April 17, 1979

INSPECTOR ____________ DISCIPLINE ____________

INSPECTOR ____________ DISCIPLINE ____________

AREA EVALUATED	CONDITION
OUTLET WORKS	The outlet works consists of a low-level outlet through the spillway. The outlet and gate lift mechanism were under water at the time of inspection and are inoperable. The approach and discharge channels are natural channels. Water can also be wasted through a vertical turbine pump located in the pumping station at the right abutment. The approach channel for the turbine pump intake has stone masonry training walls with a gunite facing. Some of the gunite facing has spalled off. The tailrace is separated from the main discharge channel by a stone masonry wall, which appeared to be in good condition.

PERIODIC INSPECTION CHECK LIST

PROJECT WILLIMANTIC RESERVOIR DAM DATE April 17, 1979

INSPECTOR ____________ DISCIPLINE ____________

INSPECTOR ____________ DISCIPLINE ____________

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	Natural channel
General Condition	Not observable
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Not observable
b. Weir and Training Walls	Concrete spillway crest and training wall, stone masonry right training wall.
General Condition of Concrete	Fair
Rust or Staining	None observed
Spalling	Yes
Any Visible Reinforcing	None observed
Any Seepage or Efflorescence	None observed
Drain Holes	None
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Channel	Right side - not visible, under water Left side - natural ground, fair condition.
Other Obstructions	Brush and small trees piled in left side of channel.

APPENDIX B

ENGINEERING DATA

Appendix B-1

Operating and Maintenance Records Location

Victor J. Galgowski, Dam Safety Engineer
Department of Environmental Protection
State Office Building
165 Capitol Avenue
Hartford, Connecticut 06115

Mr. Homer Roy, Superintendent of Water Works
P. O. Box 257
Willimantic, Connecticut 06226

APPENDIX B-2

NO COPIES OF PAST INSPECTION REPORTS OR

CORRESPONDENCE AVAILABLE

APPENDIX B-3

RECORD DRAWINGS AND SKETCHES

CONSTRUCTION OF WILLIMANTIC DAM

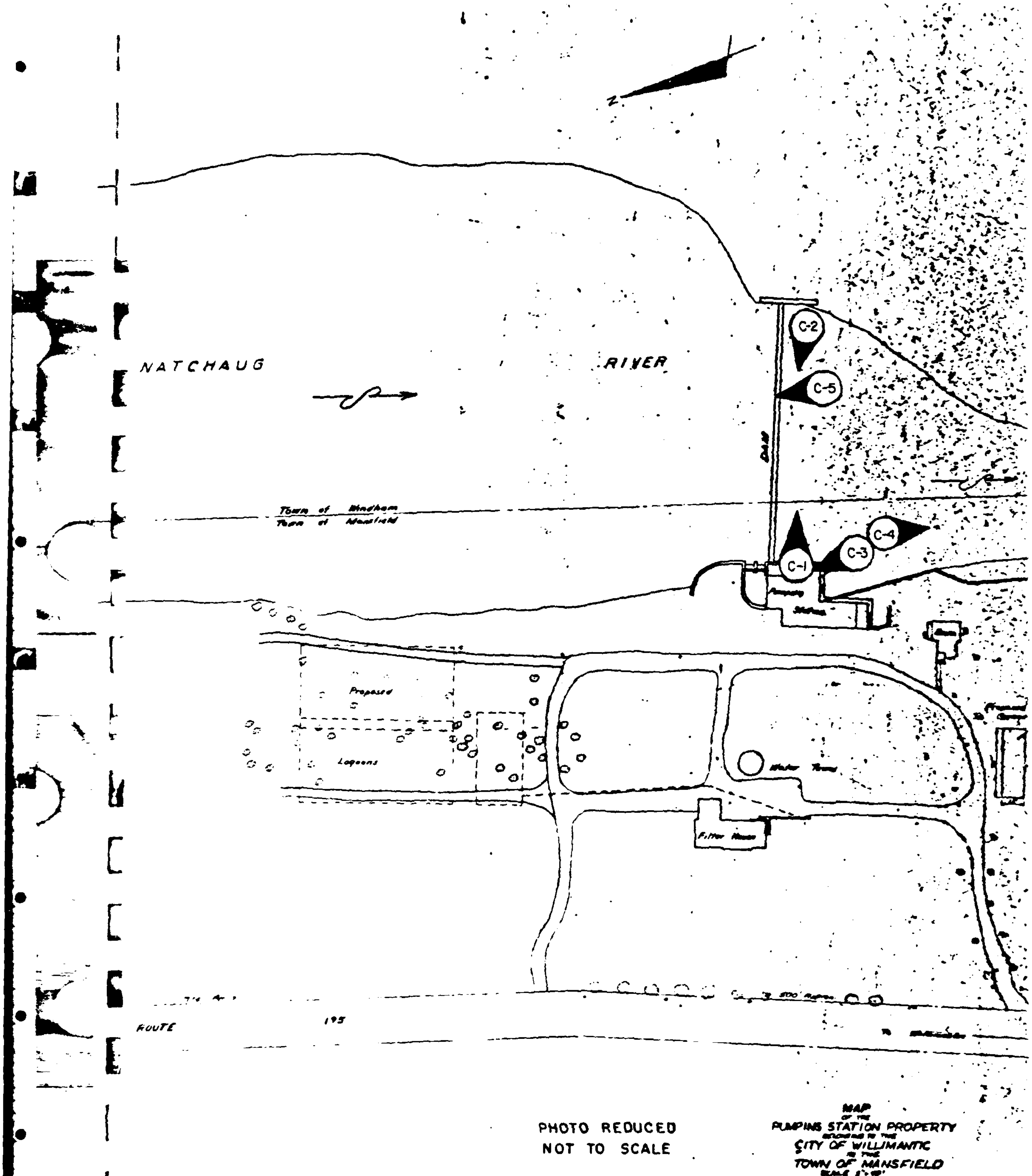


PHOTO REDUCED
NOT TO SCALE

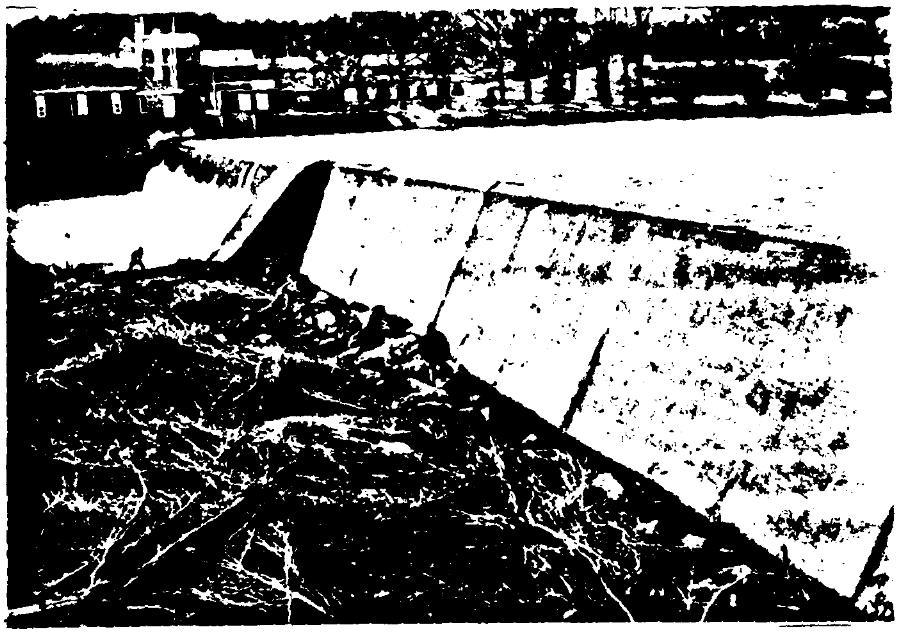
WILLIMANTIC RESERVOIR DAM

PHOTO INDEX

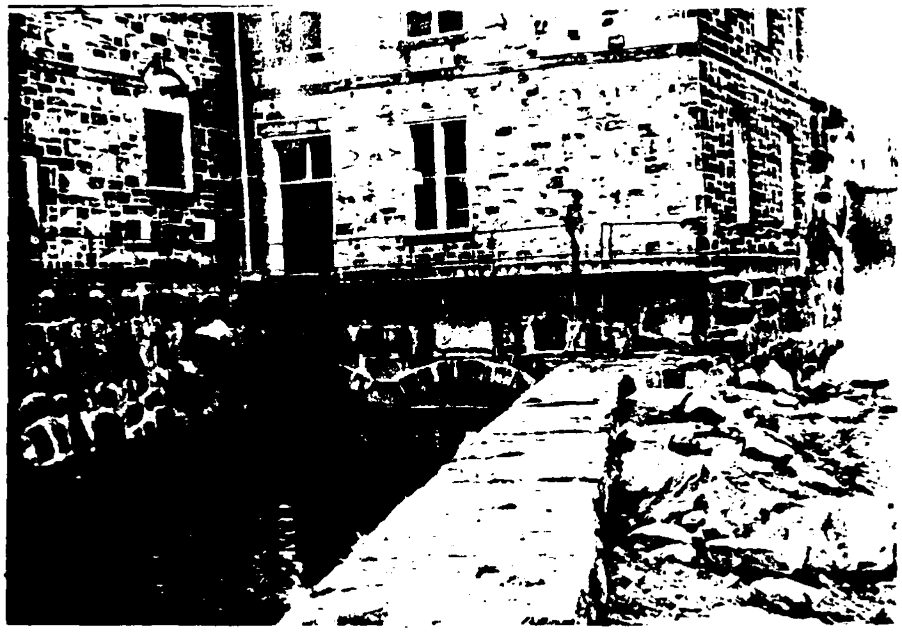
APPENDIX C

PHOTOGRAPHS

C-1 Downstream face of Dam looking from right abutment.



C-2 Downstream face of Dam looking from left abutment.



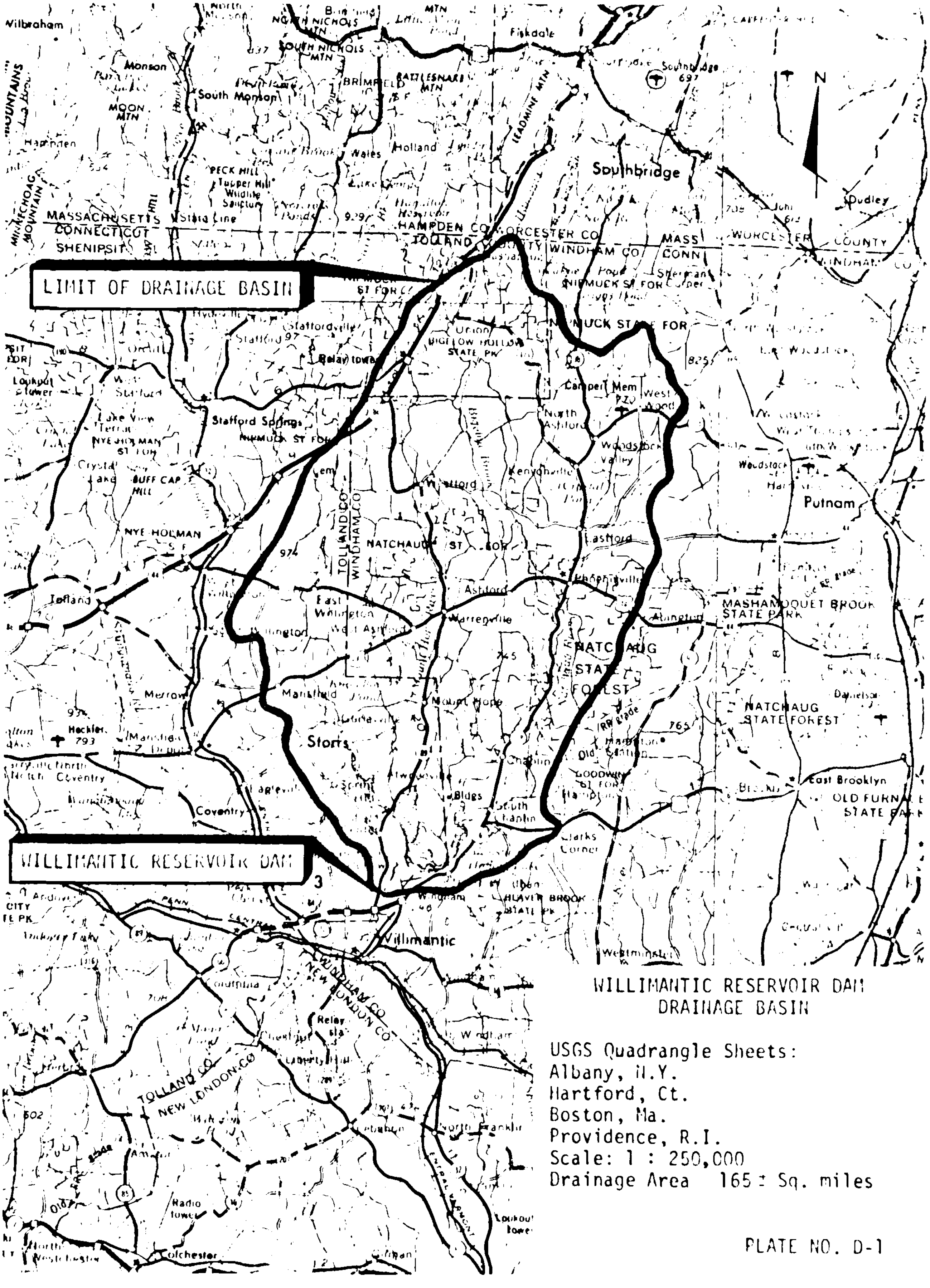
C-3 Pumping Station and Tailrace.

C-4 End of Pumping Station Tailrace and Nachaug River Downstream.

C-5 Spalled Concrete Face of Overflow Spillway.

APPENDIX D

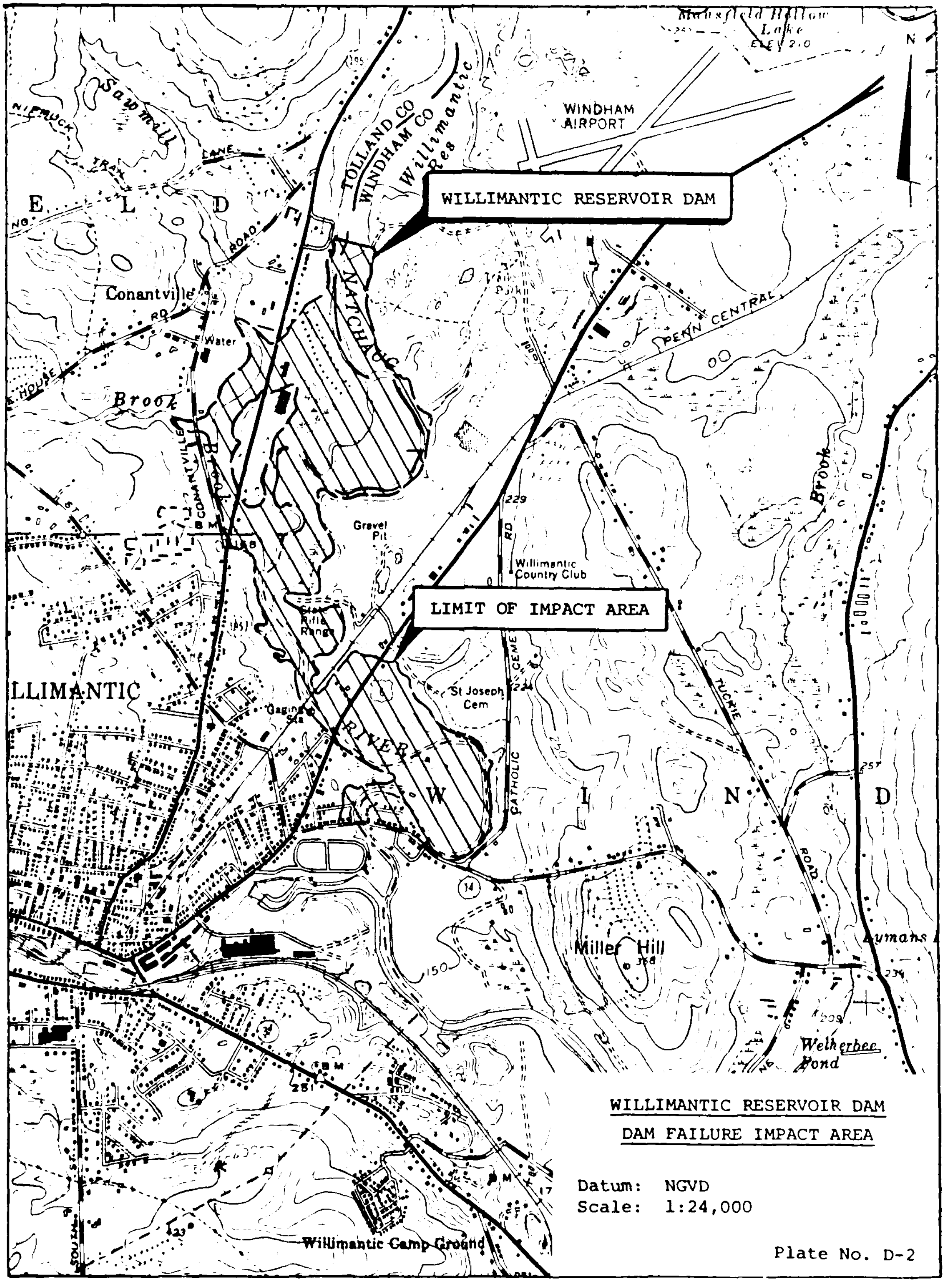
HYDROLOGIC AND HYDRAULIC COMPUTATIONS



WILLIMANTIC RESERVOIR DAM
DRAINAGE BASIN

USGS Quadrangle Sheets:
Albany, N.Y.
Hartford, Ct.
Boston, Ma.
Providence, R.I.
Scale: 1 : 250,000
Drainage Area 165 ± Sq. miles

PLATE NO. D-1



WILLIMANTIC RESERVOIR DAM

DAM FAILURE IMPACT AREA

Datum: NGVD
Scale: 1:24,000

Plate No. D-2

A. Size Classification Willimantic Reservoir Dam

Height of dam = 29.0 ft.; hence Small

Storage capacity at top of dam (elev. 189.27) = 1670 AC-FT.; hence Intermediat

Adopted size classification Intermediate

B.i) Hazard Potential

This dam is located just upstream of City of Willimantic.
and is a water supply source to the City.
Failure of the dam will cause appreciable damage
to Route 6 and will adversely affect the Water Supply System

ii) Impact of Failure of Dam at Maximum Pool (Top of Dam)

It is estimated from the rule of "thumb" failure hydrograph, that the following adverse impacts are a possibility by the failure of this dam.

a) Loss of life ; to lives can be lost.
b) Loss of homes Yes ; 0 to 5 homes can be lost.
c) Loss of buildings Yes ; 0 to 3 buildings can be lost.
d) Loss of highways or roads Yes ; Rt. 6 roads can be damaged.
e) Loss of bridges Yes ; 1 to 3 bridges can be lost.
f) Miscellaneous Yes ; Water supply and other Utilities can be disrupted.

The failure profile can affect a distance of 17000 feet from the dam. For water surface elevation, see next page in Appendix D.

C. Adopted Classifications

HAZARD	SIZE	TEST FLOOD RANGE
High	Intermediate	Full PMF

Adopted Test Flood = Full PMF = 635 CSM
= 106,000 CFS

D. Overtopping Potential

Drainage Area = 167.0 sq. miles
Spillway crest elevation = 181.27 182.47 NGVD
Top of Dam Elevation = 189.27 NGVD
Maximum spillway discharge
Capacity without overtopping of dam = 38125 CFS
"test flood" inflow discharge = 118000 CFS
"test flood" outflow discharge = 106000 CFS
% of "test flood" overflow carried by spillway without overtopping = 36%
"test flood" outflow discharge portion which overflows over the dam = 67875
% of test flood which overflows over the dam = 64%

Estimating Maximum Probable Discharges - Inflow and Outflow Values   Date of Inspection: 4/17/79

Name of Dam Willimantic Reservoir Dam ; Location of Dam Willimantic , Town Willimantic

Watershed Characterization Moderately hilly with storages and swamps upstream ; 16.70 sq. miles of drainage area is swampy or occupied by storage reservoirs

Adopted "test" flood = one PMF = ______ CSM = ______ CFS; Re = Effective Rainfall = 19.0 inches

D.A. = Drainage Area (Gross) = 167.0 Square Miles; Basin Slope =0.01-0.02 hence; moderate

S.A. = Surface Area of Reservoir = 0.18 Square Miles; Time of Concentration 15 - 20 hours.

Shape and Type of Spillway = overflow, curved ogee, vertical fill, sharp crest.

B = Width of Spillway = 490.0 feet; C = Coefficient of Discharge = (3.87-Friction) = 3.80

Maximum Capacity of Spillway Without Overtopping = 38125 CFS = 36 % of test flood

Top of Dam Elevation = 189.27 ; Spillway Crest Elevation = 181.27 for 270.0 ft. and 182.47 for additional 220 feet.

Overflow portion of Length of Dam = 490 ft. ; C = Coefficient of discharge for Dam = 3.80

Name of Dam	Test Flood Q_p		Inflow Characteristics		Outflow Characteristics First Approximation			Outflow Characteristics Second Approximation			Outflow Characteristics Third Approximation (Adopted)		
	CSM	CFS	h_0 in feet	S_0 in in.	Q_{p1} CFS	h_1 in ft.	S_1 in in.	S_2 in in.	h_2 in ft.	Q_{p2} CFS	S_3 in in.	h_3 in ft.	Q_{p3} CFS
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Williamantic Reservoir Dam	PMF =635=	89000 106000	These discharges are the peak rate of discharges at Mansfield Hollow Dam located 1.25 miles upstream,								0.20 0.215	14.7 16.6	With Mansfield Hollow 89000-----Empty 106000-----Full
	1/2 PMF =317=	14000 53000	and adopted as outflow discharges at the dam site. "	"	"	"	"	"	"		0.07 0.133	4.4 10.30	14000-----Empty 53000-----Full

Q_p = Discharge; h Surcharge height; S = Storage in inches   NOTE: Outflow discharge values are computed as per COE guidelines.

"Rule of Thumb Guidance for Estimating Downstream Dam Failure Discharge"

BASIC DATA

Name of dam Willimantic Reservoir Dam Name of town Willimantic

Drainage area = 167 sq. mi., Top of dam 189.27 NGVD

Spillway type = overflow, uncontrolled, ogee Crest of spillway 181.27 -182.47 NGVD

Surface area at crest elevation = 0.18 Sq. M.

Reservoir bottom near dam = 160.0 NGVD

Assumed side slopes of embankments 2:1

Depth of reservoir at dam site 29.0 = y_o = 29.0 ft.

Mid-height elevation of dam = 174.77 NGVD

Length of dam at crest = 491.3 feet

Length of dam at mid-height = 433 feet

28% of dam length at mid-height = W_b = 123 feet

Step 1:

Elevation (NGVD)	Estimated Storage in AC-FT	
181.27	750	Crest elevation
183.27	980	
185.27	1220	
187.27	1550	
189.27	1670	Top of Dam
191.27	1900	
195.27	2130	
197.87	2360	Test Flood elevation

Step 2:

$$Q_{p1} = \frac{8}{27} W_b \sqrt{g}\; Y_o^{3/2}$$ + spillway discharge.

Failure Discharge = 50311 CFS

NOTE: Failure of dam is assumed to be instantaneous when pool reaches top of dam and is also assumed to be partial width and full depth failure.

- Location of failure is on lower spillway portion.

Willimantic Reservoir Dam

Dam Failure Analysis

1. Failure discharge with pool at top of dam (elev. 189.27) = 50311 CFS
2. Depth of water in reservoir at time of failure = 29.0 ft.
3. Maximum depth of flow downstream of dam at time of failure = 20 ft.
4. Water surface elevation just downstream of dam at time of failure = 179.0 NGVD

The failure discharge of 50311 CFS will enter Natchang River and flow downstream 17000 feet until the brook crosses Route 6. There is significant valley storage in this 17000 feet length of brook to reduce the discharge substantially. Also due to roughness characteristics, obstructions and frictional losses, it is very likely that the unsteady dam failure flow will dissipate its wave and kinetic energy and thus convert to steady and uniform flow obeying Manning's formulae 17000 feet downstream. The failure profile will have the following hydraulic characteristics:

DISTANCE FROM THE DAM	WATER SURFACE ELEVATION NGVD	REMARKS
0 + 00	189.27	Upstream of dam
0 + 00	179.00	Downstream of dam
10 + 00	177.00	
20 + 00	175.00	
30 + 00	174.00	
40 + 00	173.00	
50 + 00	172.00	
70 + 00	171.00	
90 + 00	170.00	
110 + 00	169.00	
130 + 00	168.00	
150 + 00	167.00	
170 + 00	166.00	

Beyond 17000 feet and until the brook joins Shetucket River, the failure discharge will flow in the below given channel characteristics:

Q = 45000 CFS; S = 0.007 ±

n = 0.05 ∓; b = varies; d = 18.80 feet

Side slopes = 1V or 2H.

Willimantic Reservoir Dam

COMPUTATIONS FOR
SPILLWAY RATING CURVE AND
OUTLET RATING CURVE COMPUTATIONS

Spillway width = 269.9 @ El.= 181.27 Ft.; 221.4 @ El.= 182.47 " Spillway crest elevation = 181.27; 182.47 NGV

Length of dam = 491.3 feet; Top of dam elevation = 189.27 NGV

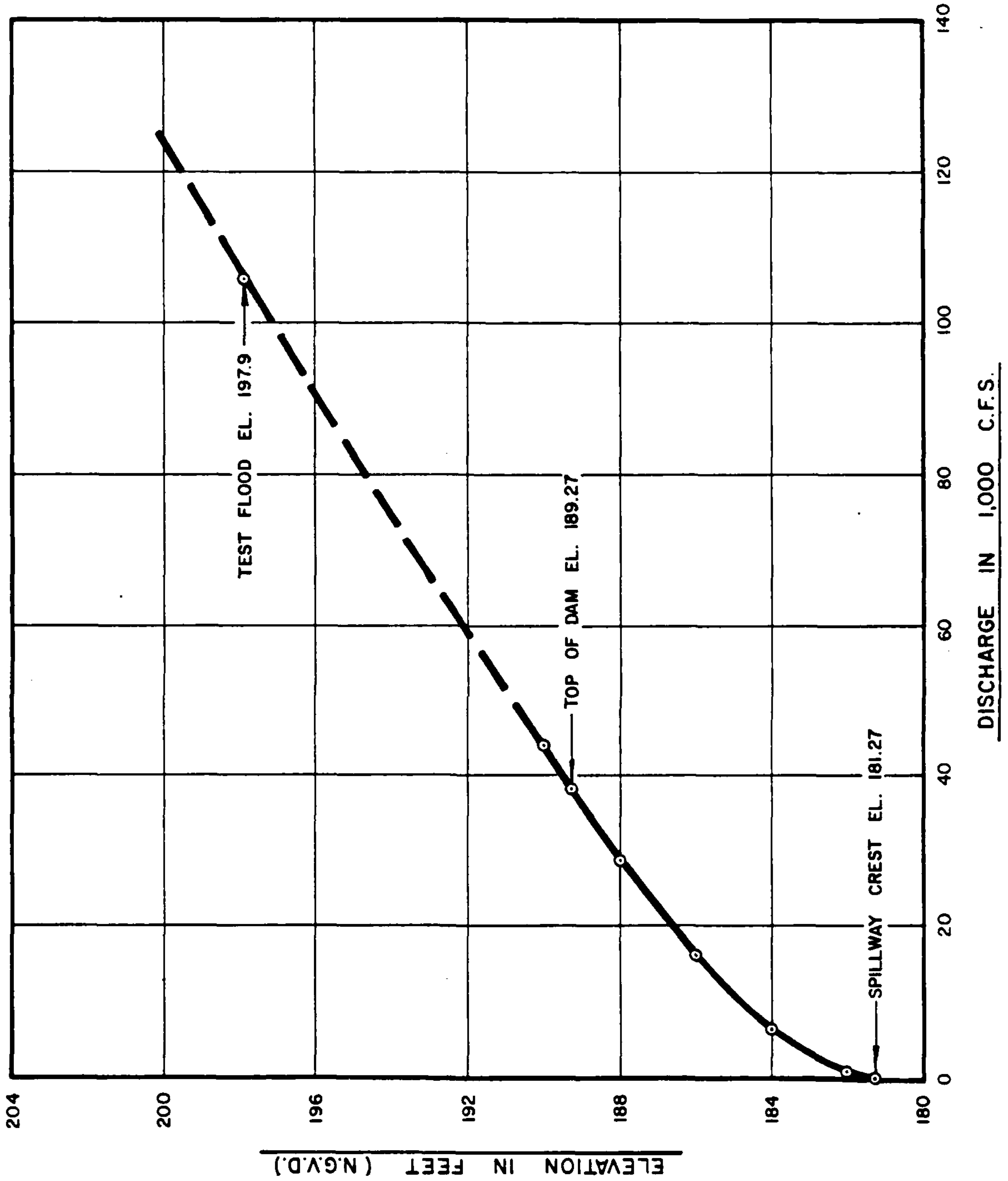
C = 3.80

i) SPILLWAY RATING CURVE COMPUTATIONS

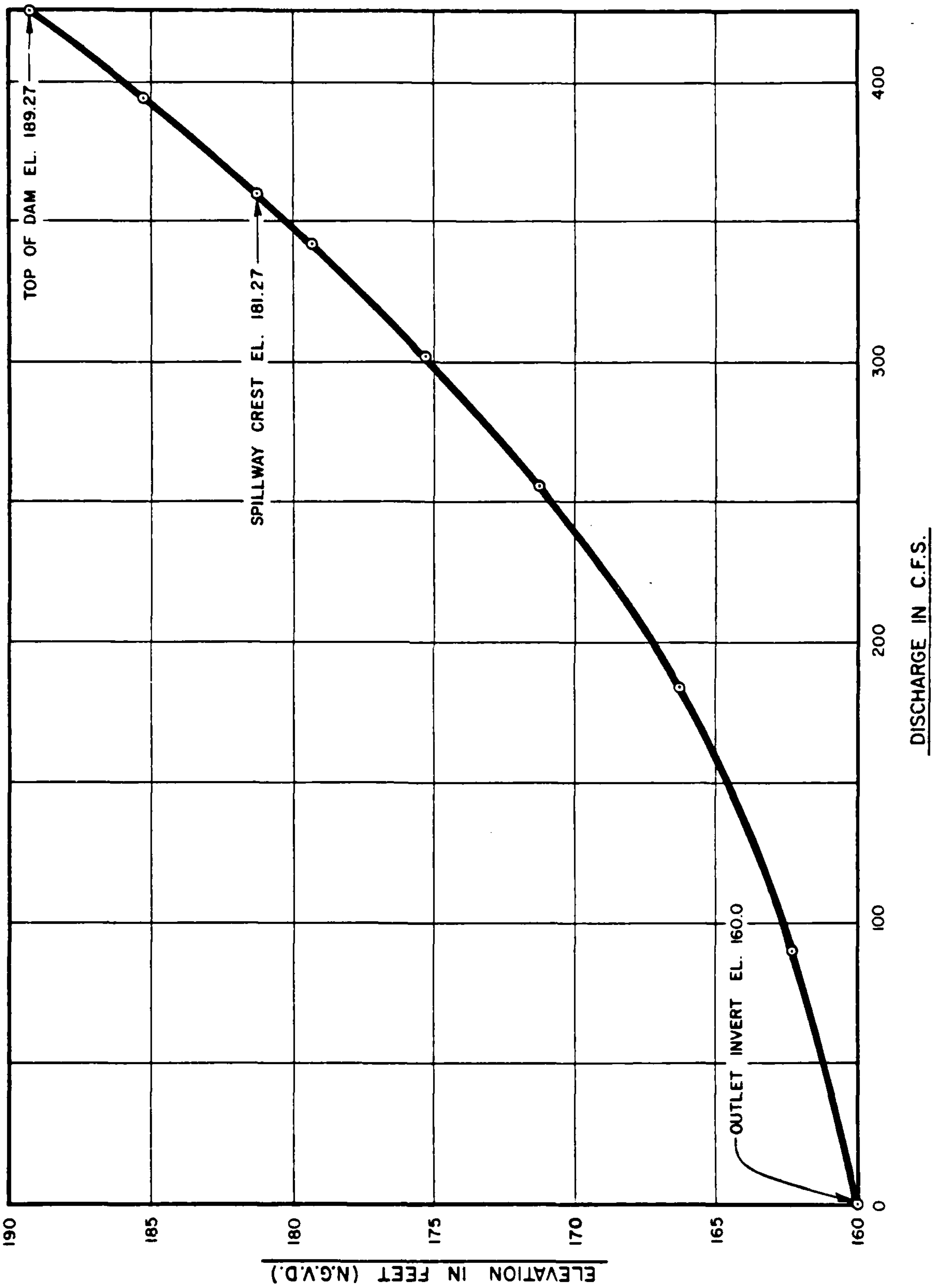
Elevation (ft.) NGVD	Spillway Discharge (CFS)	Remarks
181.27	0	Spillway crest for 200 ft. long
182.00	513	Spillway crest for 200 ft. long
182.47	1348	
184.00	6218	
186.00	16130	
188.00	28847	
189.27	38125	Top of Dam
190.00	44000	

ii) OUTLET RATING CURVE COMPUTATIONS

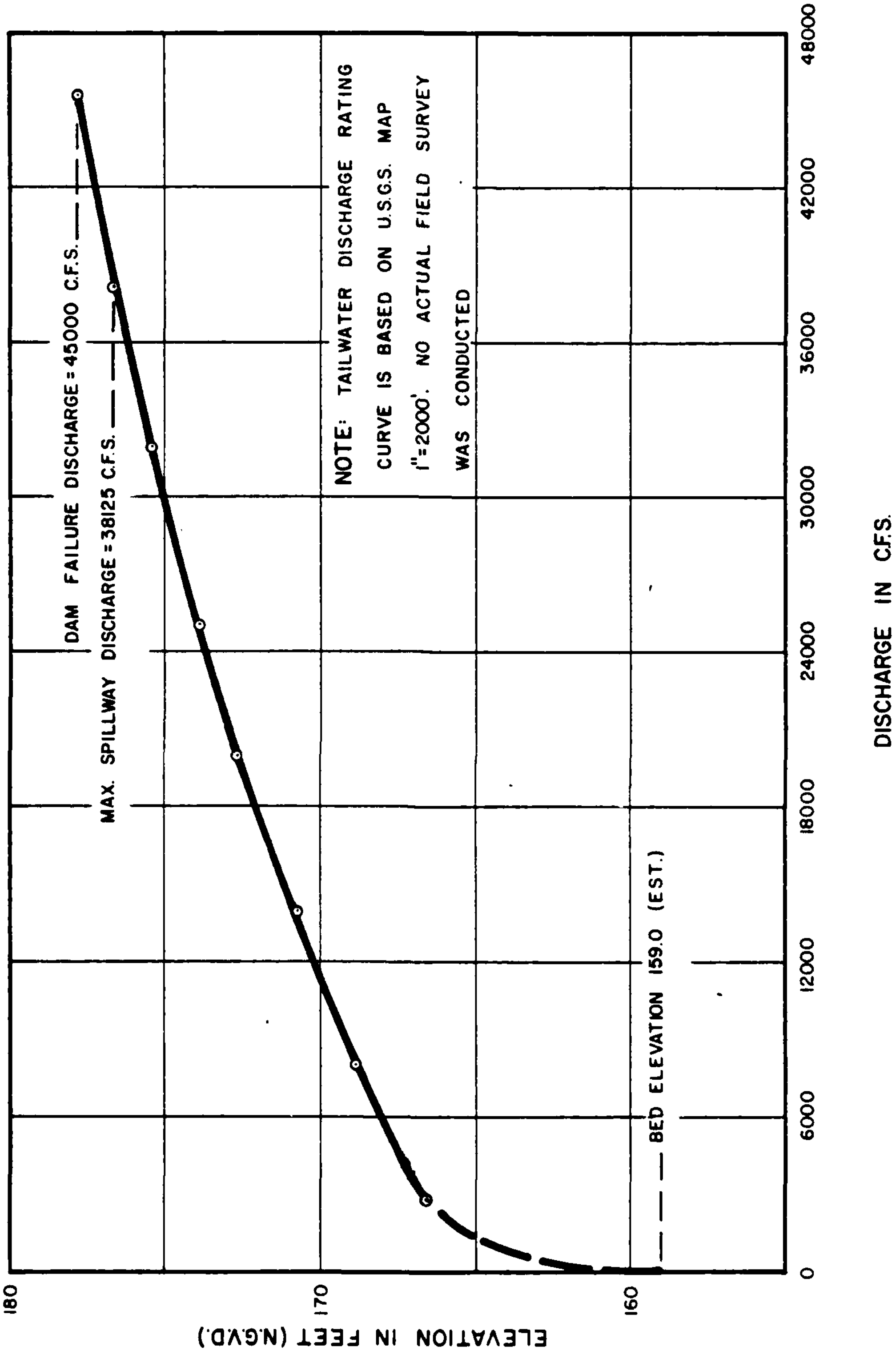
Elevation (ft.) NGVD	Discharge (CFS)	Remarks
189.27	425	Top of Dam
187.27	410	
185.27	394	
183.27	377	
181.27	360	Spillway crest
179.27	342	
175.27	302	
171.27	256	
166.27	184	
162.27	90	



WILLIMANTIC RESERVOIR DAM
SPILLWAY RATING CURVE



WILLIMANTIC RESERVOIR DAM
OUTLET WORKS RATING CURVE



WILLIMANTIC RESERVOIR DAM
TAILWATER DISCHARGE RATING
CURVE

Mr. Finegan [illegible]

Mr. Finegan/jdt/630

NEDED-W

15 September 1977

Mr. David McCartnary
District Chief
U.S. Geological Survey
Water Resources Division
135 High Street, Room 235
Hartford, Connecticut 06103

Dear Mr. McCartnary:

This is in response to recent telephone request by Mr. William Kaerhle of your staff concerning discharges from Mansfield Hollow Lake for various recurrence intervals. It is understood the information will be used in a HUD insurance study for the Natchaug River in Willimantic, Connecticut.

As you are aware, each reservoir is designed to store a volume of runoff from its upstream watershed, not to impound a selected peak discharge flood. During flood periods, runoff is temporarily stored in the reservoirs, and controlled discharges are made through the outlet works (concrete conduits at the bottom of the dams). Controlled releases through the outlet works are influenced by a number of hydrologic factors - downstream river conditions, channel capacities, travel times to downstream communities, present weather and predicted rainfall, snow cover and snowmelt.

However, once the water level in a reservoir rises above the spillway crest, uncontrolled spillway discharge occurs. Hydrologic studies performed during the design phase of each project indicates our reservoirs will fill to spillway crest elevation with a recurrence interval varying from 35 to 50 years, depending upon the amount of flood control storage in each reservoir and the hydrologic characteristics of each watershed.

Once a reservoir is completely filled, the amount of water discharging over the spillway is related to several factors - reservoir inflow, length of spillway, height of water above spillway and surcharge storage. We have not made any frequency studies to determine the exact water levels above spillway crest in Mansfield Hollow Lake nor have we determined the amount of controlled releases which would be discharged through the concrete conduits during such rare events. However, in an attempt to provide information for your consideration, the following tabulation has been prepared. The nondamaging channel capacity is used by the Corps for normal flood regulation purposes.

Recurrence Interval (years)	Estimated Discharge (cfs)
10	2,900
50	3,000
100	4,000
Standard Project Flood	14,000
Nondamaging Channel Capacity	2,900

The standard project flood is a synthetic flood developed by the Corps for demonstration purposes. Although a specific frequency has not been assigned, it can be considered in the range of a 500-year event for insurance purposes.

Sincerely yours,

JOE B. FRYAR
Chief, Engineering Division

cy furn:
Mr. Finegan
Flood Plain Mgmt.
Engrg Div Files

MANSFIELD HOLLOW DAM OPERATIONS
(Effects and Flood Damages Downstream)

Note: Reproduced from Thames River Flood Control Project - Mansfield Hollow Dam - Natchaug River, Connecticut, by U.S. Army Corps of Engineers.

7. Operation of the outlets. - a. Relation to 7-reservoir Comprehensive Plan for Flood Control in the Thames River Basin. - The Mansfield Hollow Reservoir will ultimately be operated as an integral part of the 7-reservoir Comprehensive Plan for Flood Control in the Thames River Basin to effect a maximum reduction of flood damages in the Thames River Basin as a whole. All seven reservoirs will be effective in modifying the flow of the Shetucket River from Norwich, Conn., to the mouth of the Quinebaug River, a distance of 3 miles. Between the mouth of the Quinebaug River and Willimantic, Conn., a distance of 15 miles, the flow of the Shetucket River will be modified by three reservoirs, of which Mansfield Hollow is the largest. Along the Natchaug River, which enters the Shetucket River at Willimantic, backwater from the Shetucket River affects stream flow for about a mile upstream. Above this reach for a distance of about 4 miles to the dam site the Mansfield Hollow Reservoir will control the flow of the Natchaug River. Plate No. 35 shows the

reduction in discharge and stage that would result from the Comprehensive Plan with respect to the three maximum floods of record. Plate No. 36 shows the same data on a profile for the two largest floods.

b. Channel capacities. - Four damage reaches below the Mansfield Hollow Reservoir were studies to determine which was critical with respect to discharge from the reservoir. They were No. 13a, the Natchaug River from the dam site to the U. S. G. S. gaging station on this river near Willimantic; No. 13b, the Natchaug River from the gaging station to the junction of the Natchaug and Willimantic Rivers; No. 14, the Shetucket River from its source at the junction of the Natchaug and Willimantic Rivers to the mouth of the Quinebaug River and No. 15, the Shetucket River from the mouth of the Quinebaug to tidewater at Norwich, Conn. The third reach, viz., the Shetucket from Willimantic to the mouth of the Quinebaug is the critical reach that limits the rate at which water can be discharged from the Mansfield Hollow Dam without contributing to damaging stages downstream. This is demonstrated in the following discussion.

The maximum stage that can occur without flood damage in the Natchaug River between the Mansfield Hollow Dam Site and the U. S. G. S. gaging station is 6 feet below the September 1938 flood crest as determined from stage damage surveys. The corresponding river capacity is 5,300 c.f.s. and this can be increased to 9,200 c.f.s. at a stage 2 feet higher with only $1,700 damage. The smaller discharge corresponds to about 31.4 cu. ft. per second per square mile.

The maximum stage without damage in the Natchaug below the U. S. G. S. gaging station is 12 feet below the crest of the September 1938 flood. Flood stages in this reach are controlled by backwater from the Shetucket River. A stage 12 feet below the September 1938 crest at the U. S. G. S. gaging station on the Shetucket River below Willimantic will pass about 38 cubic feet per second per square mile which means that about 6,000 c.f.s. can be discharged from the Mansfield Hollow Reservoir without causing damage along the lower Natchaug.

In the critical damage reach, which is the Shetucket River from Willimantic to the mouth of the Quinebaug River, damages start at a flood stage 17 feet below the crest of the September 1938 flood. At this stage the discharge past the U. S. G. S. gaging station, which has a drainage area of 401 square miles, is 6,500 cubic feet per second or 16.2 cubic feet per second per square mile. This means that not more than 2,600 c.f.s. can be discharged from the Mansfield Hollow Reservoir without contributing to damaging stages in this reach of the Shetucket River. During major floods it will be necessary to exceed this rate of discharge from the Mansfield Hollow Reservoir. To handle a flood of the size of that of September 1938 will require a river stage approximately 4 feet above the maximum no-damage stage or 13 feet below the uncontrolled crest of this flood. At this stage the river will discharge 13,000 c.f.s. at the U. S. G. S. gaging station or 32.5 c.f.s. per square mile. The corresponding discharge from the Mansfield Hollow Reservoir would be about 5,200 c.f.s. and damages resulting would not exceed $10,000. One building of the Baltic Cotton Mills at Sprague and 8 dwellings at Taftville would be flooded and minor railroad damage would occur at Scotland.

The Shetucket River between the mouth of the Quinebaug River and the City of Norwich has a capacity without damages under present conditions of 25,000 c.f.s. or 20 c.f.s. per square mile. The corresponding stage is 16 feet below the crest of the flood of September 1938. Completion of the authorized channel improvement at Norwich will increase the no-damage capacity of the river at the same stage to 52,000 c.f.s. or approximately 26 c.f.s. per square mile. Corresponding discharge from the Mansfield Hollow Reservoir is about 4,100 c.f.s.

c. Operation of outlet gates and use of storage. - For all normal flow of the Natchaug River and for all minor floods that will not cause discharge greater than 2,600 c.f.s. the outlet gates should remain fully open. For greater floods the reservoir should be operated so as to secure the greatest possible benefit at downstream damage centers. To obtain this objective the method of operation will vary with the magnitude of the flood and the distribution of storm rainfall on the Thames River Basin. During any flood period operation of the outlet gates should be governed, as the storm progresses, by reports of rainfall at selected stations in and around the Thames River Basin and by reports of river stages at downstream damage centers.

As indicated in the foregoing statement on channel capacities the Shetucket River between Willimantic and the mouth of the Quinebaug River has the lowest channel capacity per square mile of any reach affected by the Mansfield Hollow Reservoir. Consequently, the Mansfield Hollow Reservoir will be operated primarily, in conjunction with the proposed Andover and South Coventry Reservoirs, to effect a maximum reduction of flood peaks in this reach. Stage control within this reach is governed largely by a series of four dams at Scotland Station, Baltic, Occum and Taftville, the last being within a mile of the mouth of the Quinebaug River and having a drainage area of 508 square miles. Without lowering or lengthening these dams little can be done to lower the damage stages or to increase the channel capacity in this section of the river.

From the foregoing description of conditions it is obvious that no fixed schedule of gate operation can be established for all floods. In the early part of any flood period water should be permitted to pass through the outlet at the maximum rate possible without contributing to damaging stages downstream. As soon as it becomes apparent from reservoir inflow and from rainfall and river stage reports that this rate must be exceeded operation of the gates must be directed toward controlling the outlet discharge so that it will make the least possible contribution to the damaging flood stage. This involves planning to use all of the storage space provided by the reservoir but avoiding uncontrolled discharge over the spillway. It also involves varying the rate of discharge so that water is released at a minimum rate or not at all when the uncontrolled portion of the drainage area is contributing at maximum rate and permitting higher rates of discharge at other times when no increase in damages will result.

d. Adequacy of outlets. - To test the adequacy of the outlets and demonstrate the method of operation outlined above the two maximum floods of record, viz., March 1936 and September 1938, have been routed through the initially empty reservoir under simulated operating conditions. The results are shown on Plates No. 31 and No. 32. In the case of the September 1938 flood the outlet discharge is also shown with the gates opened sufficiently for the reservoir to act as a retarding basin, and for the March 1936 flood the outlet discharge is shown for two gates fully open for the entire flood period.

To simulate operating conditions in preparing these diagrams rainfall records in the Thames River Basin and the stream gaging record for the Shetucket River near Willimantic were studied as they might be received during the progress of a storm. For example at 3 P.M. on September 19, 1938 discharge at the gaging station in the Shetucket was 5,120 c.f.s. and increasing at the rate of 300 c.f.s. per hour which indicated that the maximum no-damage stage would be reached in 4 hours or less. To avoid exceeding this stage and compensate for flow-time from the Mansfield Hollow Dam it was assumed that closing of the gates would start at 3 P.M. and proceed gradually so as to hold the discharge at 2,600 c.f.s. until 9 P.M. on September 20. At this time the rainfall records indicated that heavy rain had been falling for 4 hours. Anticipating a peak as the result of this rain closing of the gates was assumed to be accelerated so that they were entirely closed by 9 A.M. on the 21st. At this time the rainfall reports showed that the heavy rainfall had ceased 4 hours earlier and the gates were accordingly assumed as gradually being opened for the next 12 hours or until 9 P.M. on the 21st at which time they were discharging 4,140 c.f.s. Discharge was assumed as held at this rate until about 3 A.M. on the 23rd when it was gradually reduced over the next 16 hours to 2,600 c.f.s. where it was held until the rate of inflow dropped below this rate. In selecting the maximum discharge of 4,140 c.f.s. it was assumed that by 9 P.M. on the 21st the reservoir inflow hydrograph could have been approximated from rainfall and reservoir operation records with sufficient accuracy to determine that a discharge of 4,140 c.f.s. for about 30 hours would be necessary to avoid flow over the spillway.

The operation program for the March 1936 flood was developed by the same method as for the September 1938 flood. Although higher rates of discharge in the early stages of both of these floods would have reduced the ultimate maximum rates of discharge, to justify these higher early rates would have required foresight that a major flood was to follow. Lacking this foresight there could be no justification for the release of damaging discharge until rainfall records indicated that a major flood was inevitable.

The spillway design flood has also been routed through the initially empty reservoir with the outlet gates fully open as shown on Plate No. 33. Because of the extreme improbability that this latter flood will ever occur, the results do not represent conditions to be expected in normal operation of the reservoir for flood control.

e. Time of emptying reservoir. - Under normal operating conditions it will require 12-1/2 days to empty the reservoir, after maximum pool elevation has been reached, for a flood of the size of September 1938. Similarly 12-1/2 days would be required for a flood like that of March 1936. The discharge curves corresponding to both of these times are shown on Plates No. 32 and No. 31 respectively.

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY | MO | YR
CT	186	NED	CT	013	02	CT	015	02	WILLIMANTIC RESERVOIR DAM	4144.4	7211.7	17MAY79

POPULAR NAME	NAME OF IMPOUNDMENT
	WILLIMANTIC RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	07	NATCHAUG RIVER	WILLIMANTIC	2	14000

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	OWN	FED	R	PRV/FED	SCS	A	VER/DATE
PGCTGR	1885	S	30	25	1670	750	NED	N	N		N	N		17APR79

REMARKS
21 STONE MASONRY + CONCRETE

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	491	U	491	38125												

OWNER	ENGINEERING BY	CONSTRUCTION BY
CITY OF WILLIMANTIC	UNKNOWN	UNKNOWN

REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	DEPT ENV PROT

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
CE MAGUIRE INC	17APR79	PL 92-367

REMARKS:
32-SPILLWAY IN TWO SECTIONS WITH DIFFERENT CREST ELEVATIONS

END

FILMED